Multifamily Indoor Air Quality (IAQ) & Design Considerations

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- Joined AMCA in February 2019
- Responsible for development of AMCA's education programs; staff liaison for the Education & Training Subcommittee
- Projects include webinars, online education modules, presentations at trade shows, AMCA Speakers Network and other duties as assigned.

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- Senior Application Engineer working to enhance and expand the multifamily ventilation product line
- Has worked on municipal improvement projects, machine control and guidance technologies, and provided consultant services for the Wisconsin Department of Transportation

Multifamily Indoor Air Quality & Design Considerations

Purpose and Learning Objectives

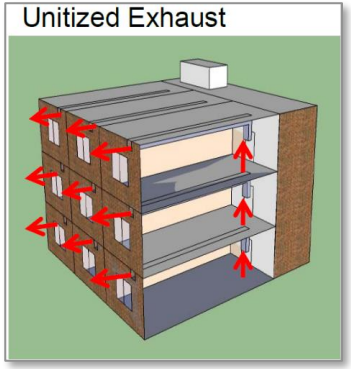
The purpose of this presentation is to discuss how effective Indoor Air Quality (IAQ) contributes to the health and comfort of residential occupants while ensuring proper ventilation and moisture management.

At the end of this presentation you will be able to:

1. Understand the importance of Indoor Air Quality.
2. Identify relevant codes and standards.
3. Describe ventilation strategies.
4. Outline residential fan sizing conventions and selection elements, including motor technology considerations.
5. Understand the importance of static pressure.

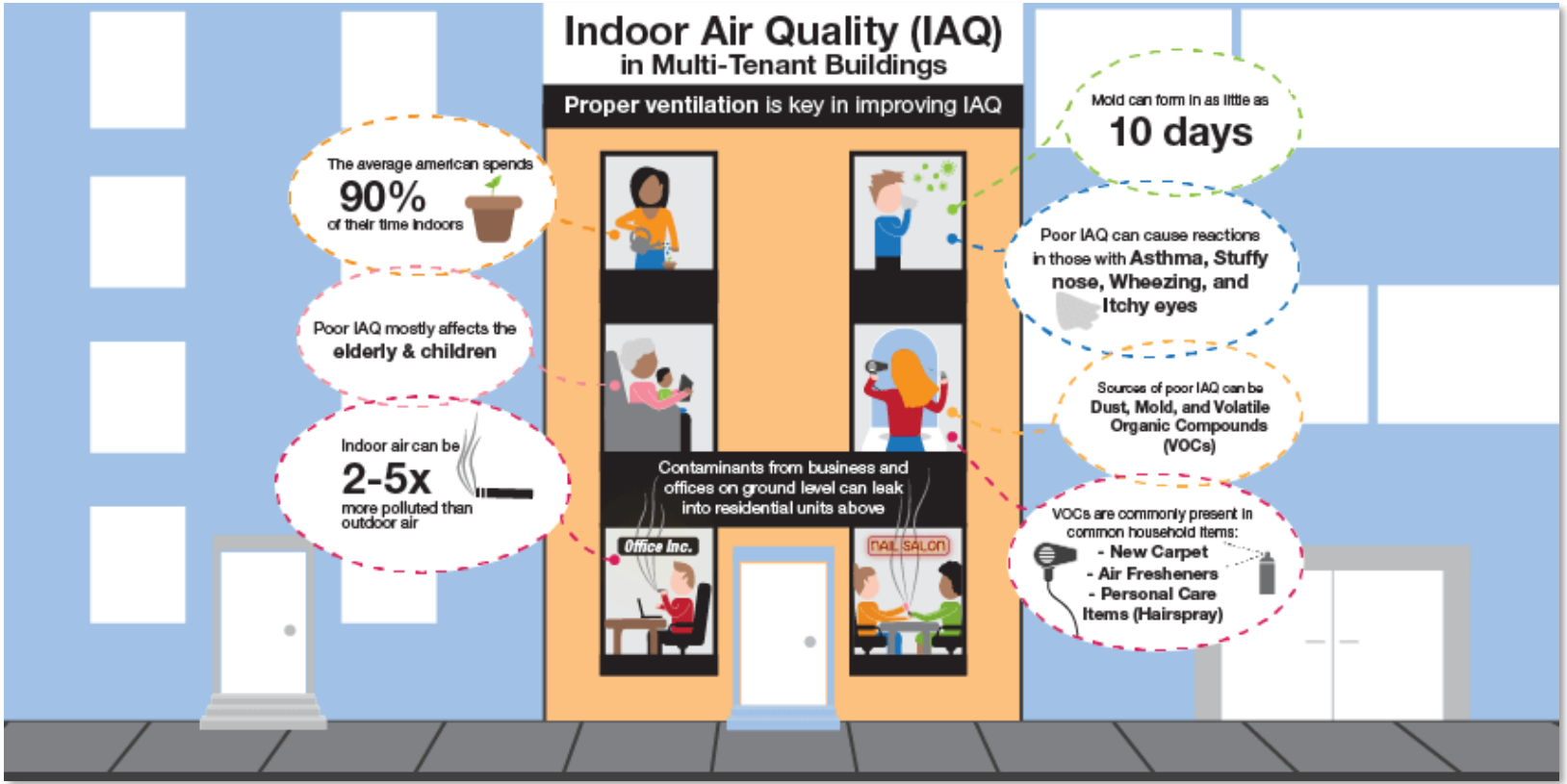
Building Types

- Multi-tenant and mixed-use buildings
  - Tower and Garden style
  - Assisted Living Facilities
  - Lodging
  - Dormitories
  - Office and Retail

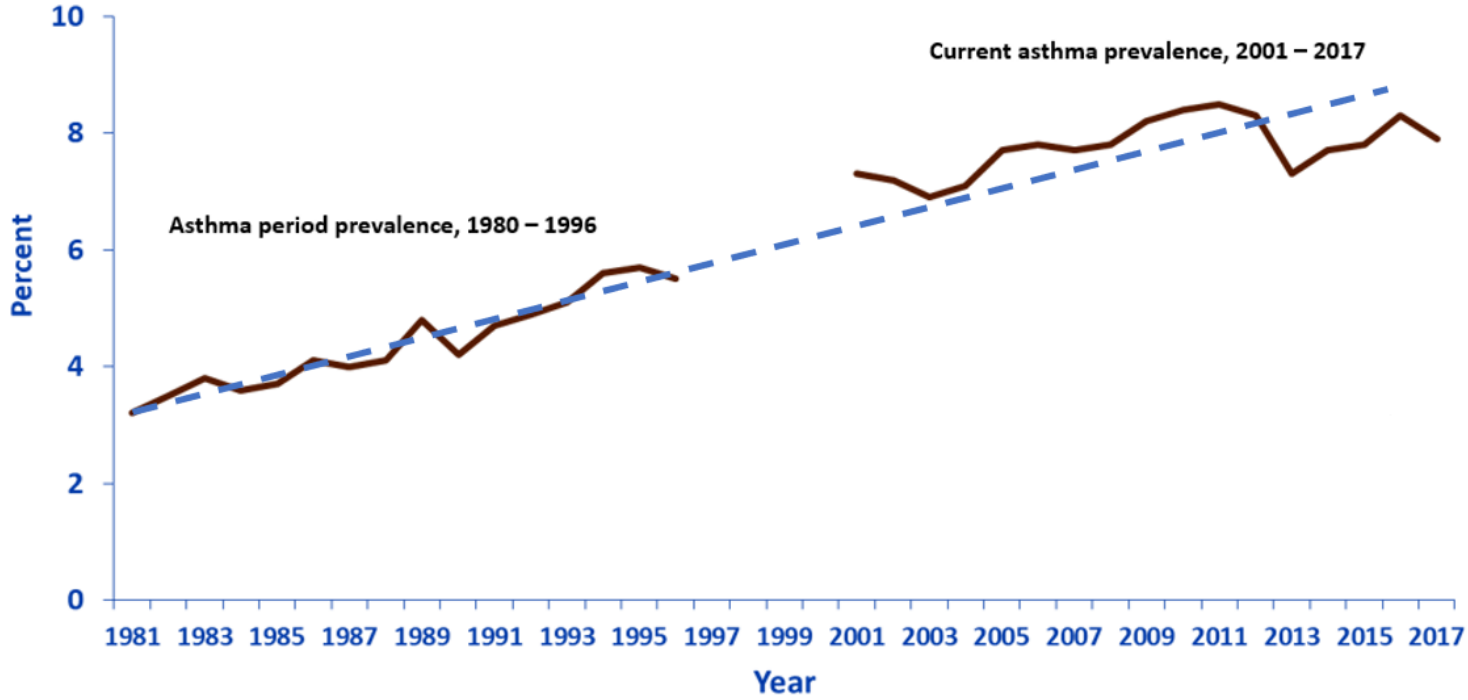


Why is Indoor Air Quality Important?

Indoor Air Quality

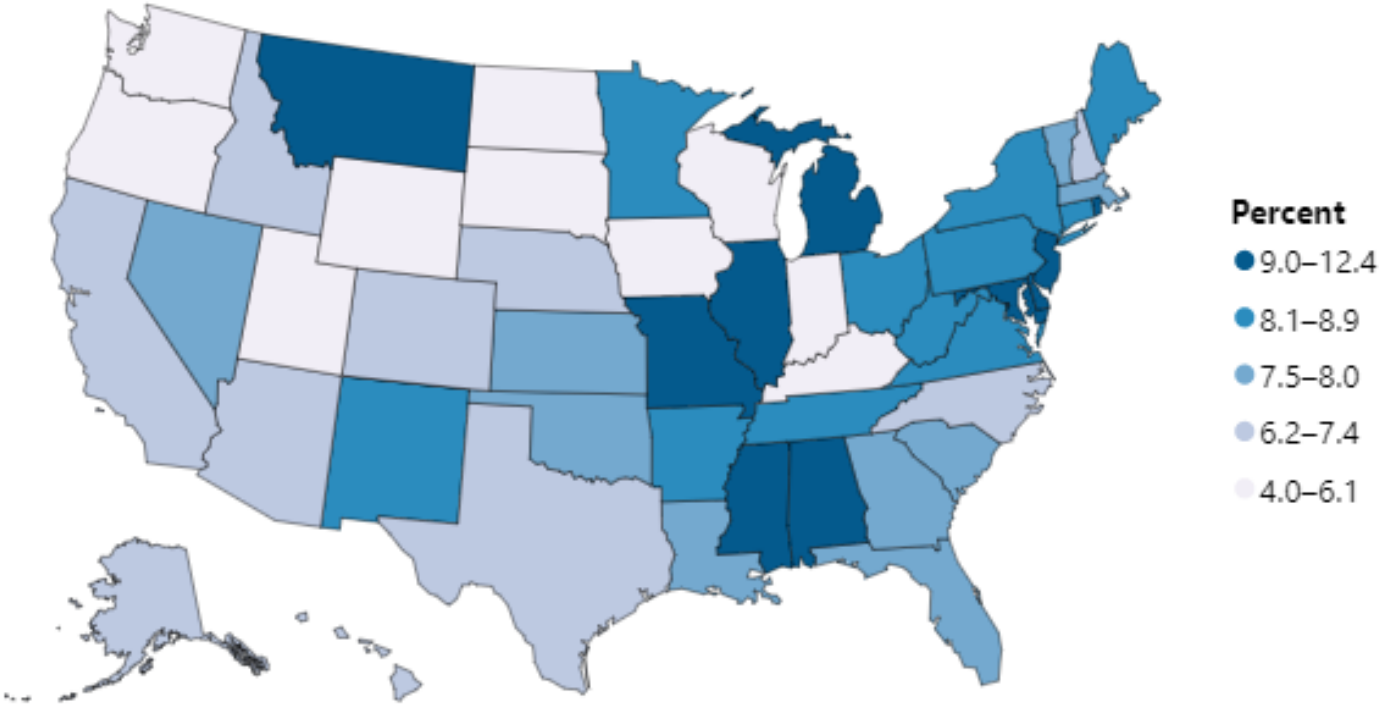


Asthma Prevalence, U.S. 1980 - 2017



Source: Centers for Disease Control

Current Asthma Prevalence by State or Territory (2018)



Source: Centers for Disease Control

Poor IAQ

Codes and Standards

Topics

- Codes as they pertain to bathroom exhaust fans:
  - ASHRAE 62.2
  - California Title 24
  - Energy Codes
- Compliance with Codes/Exemptions
- Excess Moisture Concerns

ASHRAE 62.1 and 62.2 - 2019

Set Indoor Air Quality (IAQ) standards in commercial and residential buildings

62.1 applies to commercial buildings and common areas of multi-family buildings

62.2 applies to all dwelling units (apartments or homes)

ASHRAE 62.1 and 62.2 – 2019 (continued)

ASHRAE 62.2 – 2019

- Ventilation rates can be calculated, or a table can be used.
  - This is the continuous ventilation rate required to maintain acceptable IAQ.
  - Intermittent operation can fulfill this requirement.
    - 90 CFM for 30 min

TABLE 4.1a (I-P) Ventilation Air Requirements, cfm

	Bedrooms				
Floor Area, ft^2	1	2	3	4	5
<500	30	38	45	53	60
501–1000	45	53	60	68	75
1001–1500	60	68	75	83	90
1501–2000	75	83	90	98	105
2001–2500	90	98	105	113	120
2501–3000	105	113	120	128	135
3001–3500	120	128	135	143	150
3501–4000	135	143	150	158	165
4001–4500	150	158	165	173	180
4501–5000	165	173	180	188	195

$$Q_{tot} = 0.03A_{floor} + 7.5(N_{br} + 1)$$

where

Q_{tot} = total required ventilation rate, cfm

A_{floor} = dwelling-unit floor area, ft^2

N_{br} = number of bedrooms (not to be less than 1)

ASHRAE 62.2 – 2019 (continued)

In addition to sq. ft. of space, number of bedrooms helps estimate the number of occupants

Ceiling Exhaust/Bath fans traditionally considered spot ventilation, but may also function as whole house ventilation

California Title 24

SECTION 4.506
INDOOR AIR QUALITY AND EXHAUST

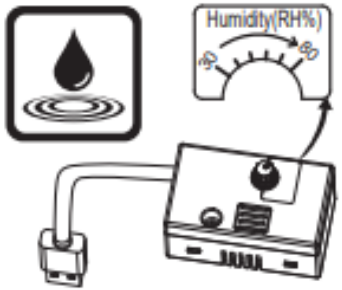
4.506.1 Bathroom exhaust fans. Each bathroom shall be mechanically ventilated and shall comply with the following:

1. Fans shall be ENERGY STAR compliant and be ducted to terminate outside the building.
2. Unless functioning as a component of a whole house ventilation system, fans must be controlled by a humidity control.
   a. Humidity controls shall be capable of adjustment between a relative humidity range of ≤ 50 percent to a maximum of 80 percent. A humidity control may utilize manual or automatic means of adjustment.
   b. A humidity control may be a separate component to the exhaust fan and is not required to be integral (i.e., built-in).

Notes:

1. For the purposes of this section, a bathroom is a room which contains a bathtub, shower, or tub/shower combination.
2. Lighting integral to bathroom exhaust fans shall comply with the *California Energy Code.*

- Humidity sensors run fan automatically to exhaust excess moisture and humidity



ENERGY STAR

Energy Code Considerations

- Requirements exist for motors from 1/12 – 1HP be 70% efficient or Electronically Commutated
  - Must be able to adjust speed
- Most bath fans are exempt based on motor size
- Many technical documents will state “Can be used to comply with…”
- Do not rely on these statements, they can be misleading

Spot Ventilation

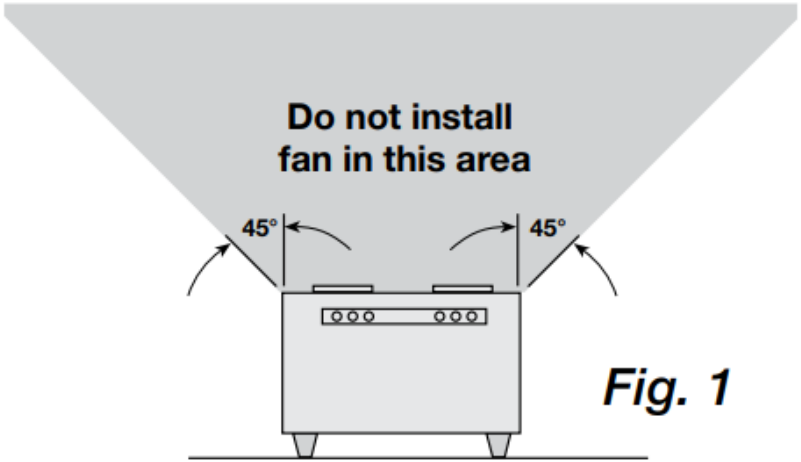
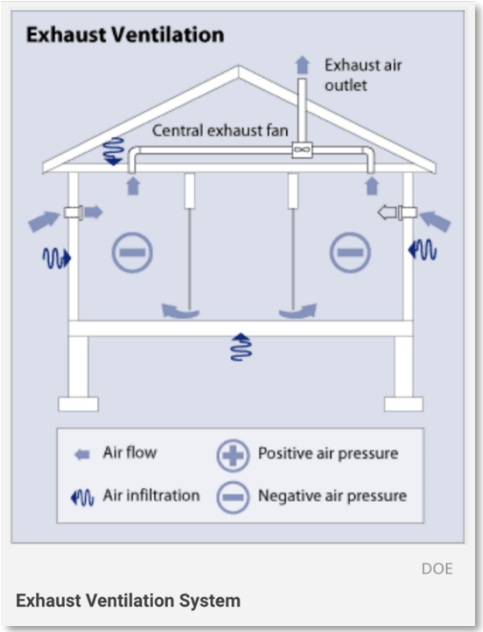


Fig. 1

Dwelling Unit Ventilation Strategies

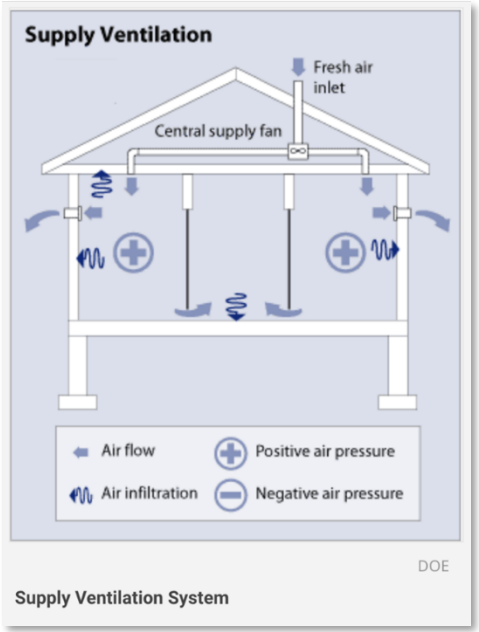
Exhaust Strategy

- Pros
  - Relatively simple and easy to install
  - Passive make up air
  - Low cost
- Cons
  - Potential for pollutants in make up air
  - Uncontrolled infiltration
  - Negative Pressure in space



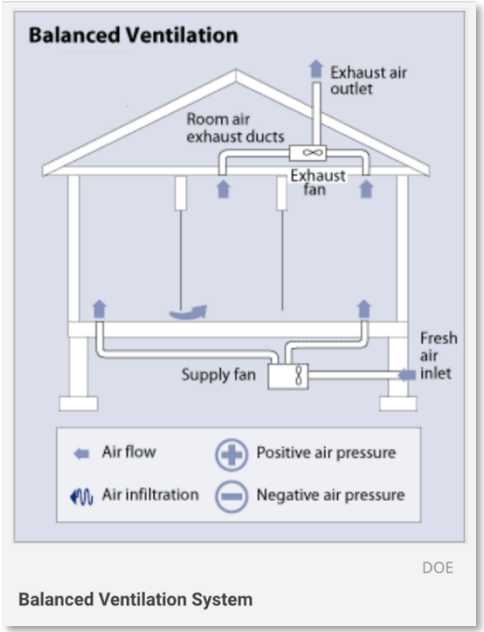
Supply Strategy

- Pros
  - Relatively simple and easy to install
  - Control how and when air enters space
- Cons
  - Potential for higher heating and cooling costs
  - Not appropriate for all climates



Balanced Strategy

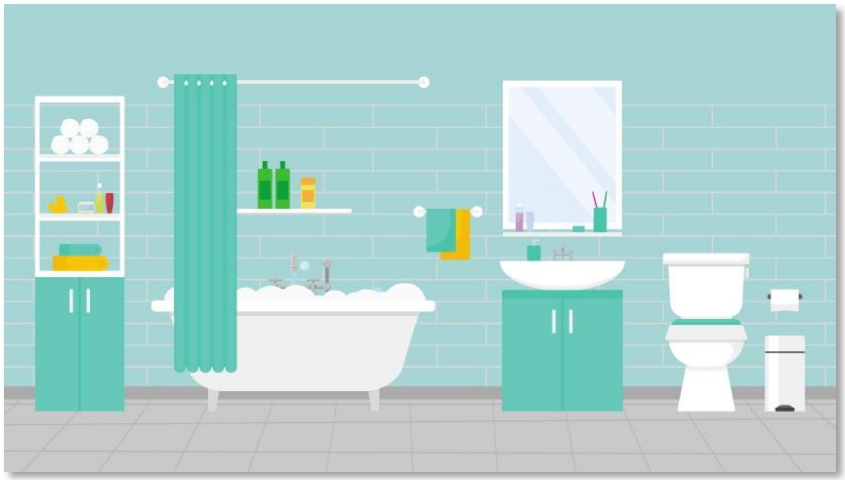
- Pros
  - Targeted, more effective solution
  - Appropriate for all climates
  - Can be achieved with ERV/HRV
- Cons
  - Higher initial cost
    - Often two fans, multiple sets of ductwork
  - More expensive to operate



Exhaust Fan Sizing and Selection

Bathroom Exhaust Fan Sizing

- Less than 100 sq. ft., size for at least 1 CFM per square foot
- Greater than 100 sq. ft., size 50 CFM per fixture
  - Toilet, shower, tub, jetted tub
- Ensure adequate make up air
  - i.e., gap under closed room door
  - Consider higher airflow to remove more moisture



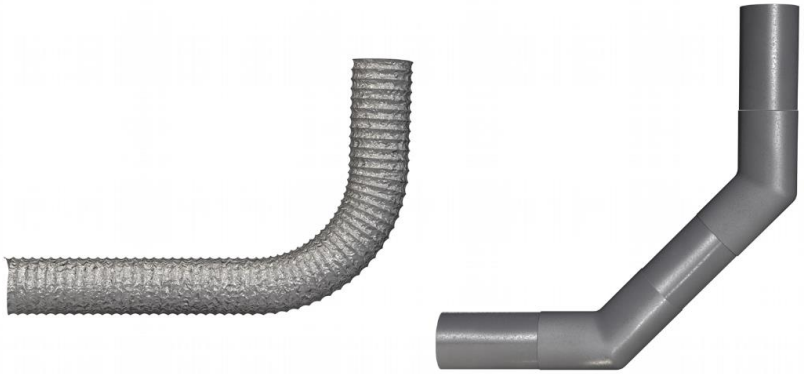
Ducting Recommendations

Elbows

Incorrect

Correct

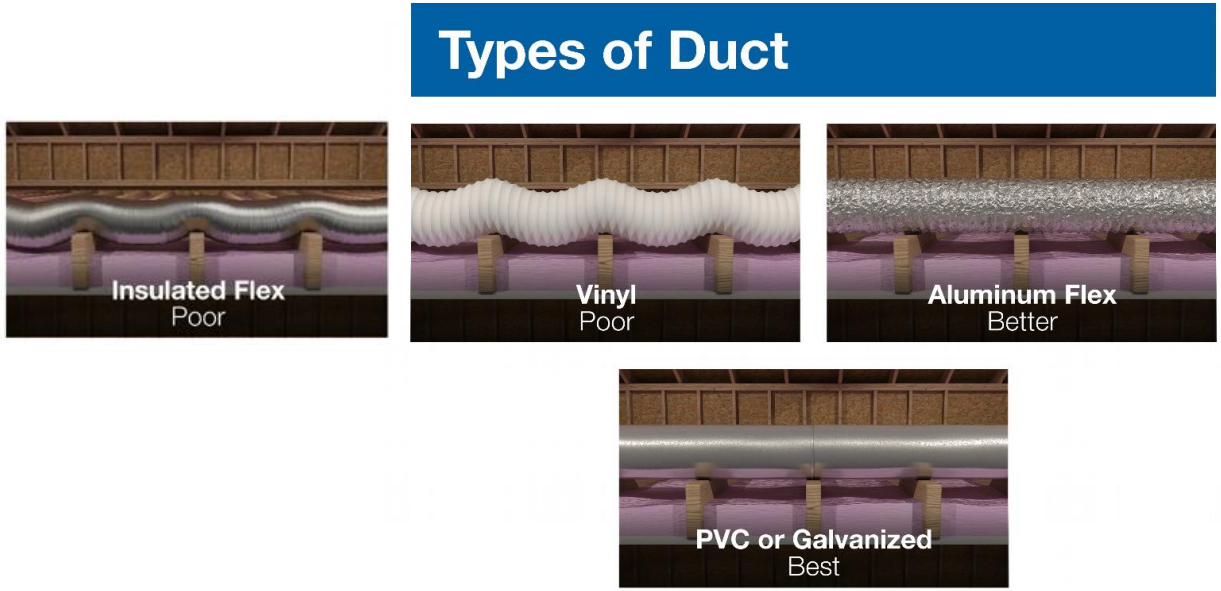
Long Radius Angle



Typical

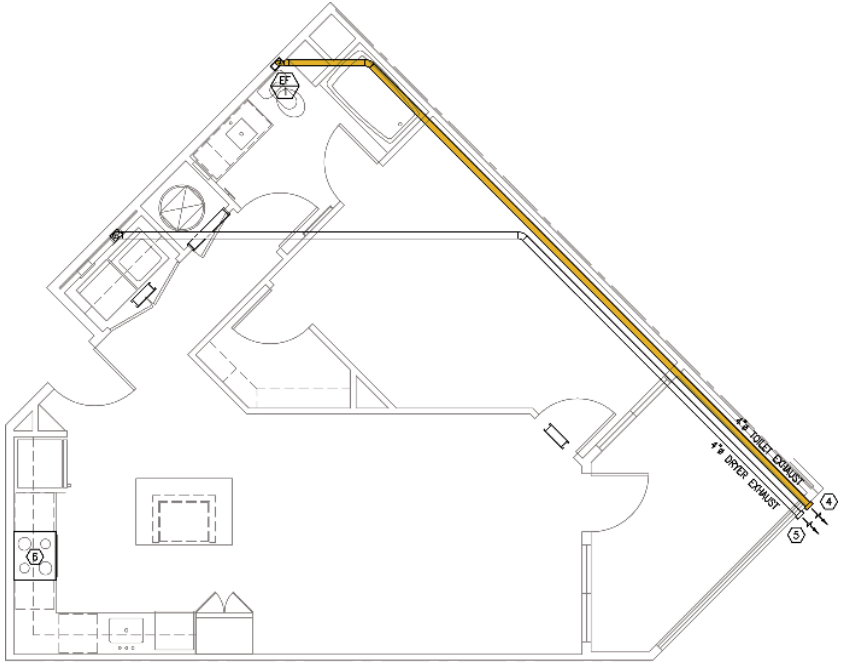
Preferred

Ensuring Effective Operation



Static Pressure Calculation

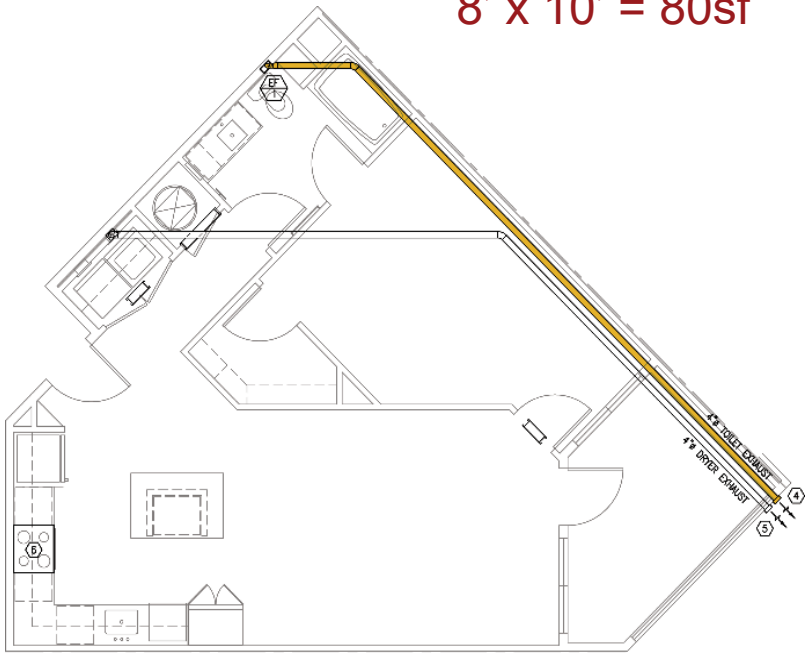
- Determine Needed CFM
- Calculate Total Effective Length
- Calculate static pressure



Determine Needed CFM

- Option 1:1 CFM/sq. ft. up to 100 sq. ft.
  - Over 100 sq. ft → 50 CFM per fixture (Shower, tub, toilet)
- Option 2: Base on air changes
  - Divide Volume of room by ACH (8 ACH is recommend)

8’ x 10’ = 80sf



Option 2

- Calculate Volume

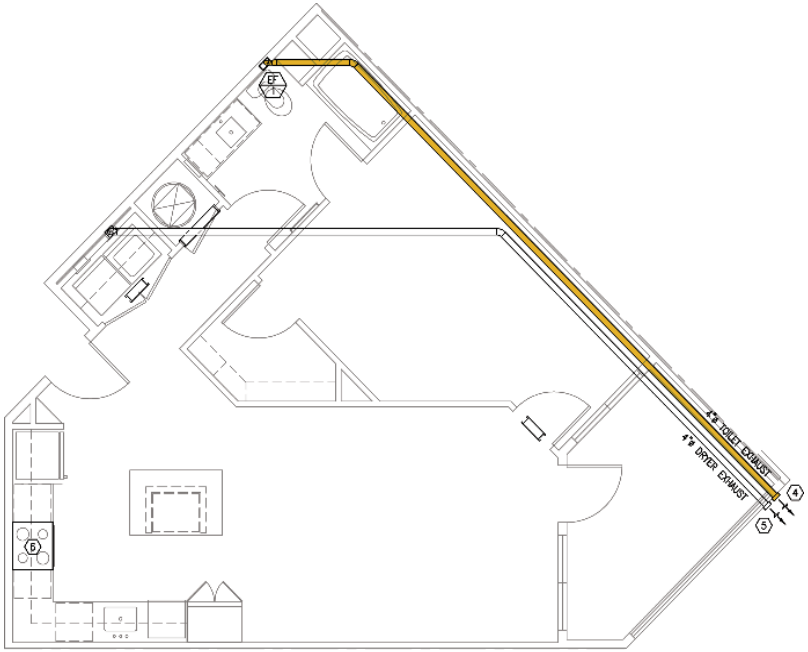
$$8\ ft\ x\ 8ft\ x\ 10ft = 640cf$$

- Calculate minutes per air change

$$\frac{1\ hour}{60\ min} x \frac{8AC}{hour} = \frac{1AC}{7.5\ min}$$

- Determine CFM

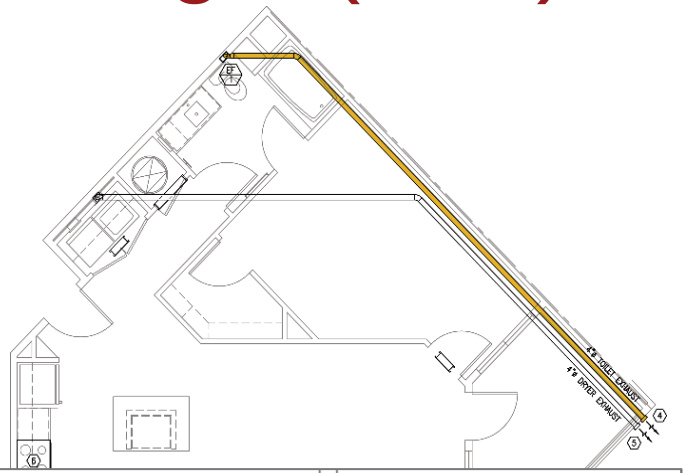
$$640\ cf x \frac{1AC}{7.5\ min} = \frac{85.3\ cf}{min}$$

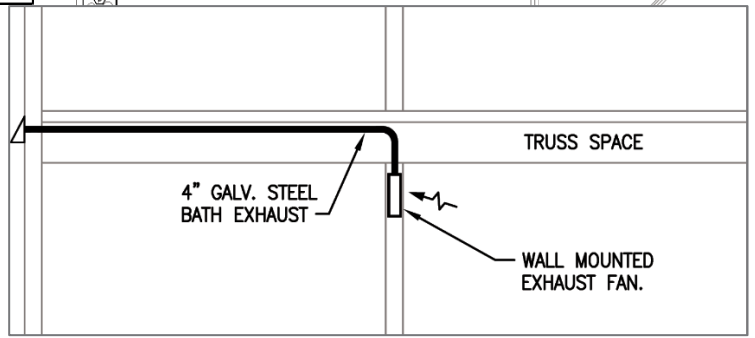


Calculate Total Effective Length (TEL)

Equivalent Duct Length for Bath Fans		
	Duct Diameter	
Duct Type or Fitting	***4 inch***	***6 inch***
Smooth metal duct	Same as measured length	
Flex duct	2x duct length	2x duct length
Insulated flex duct	2.5x duct length	2.5x duct length
Roof or wall cap	30 ft.	40 ft.
45° adjustable elbow	4 ft.	6 ft.
90° adjustable elbow	15 ft.	12 ft.
90° adjustable smooth elbow	4 ft.	6 ft.

Source: Best Practices Guide for Residential Construction, John Wiley and Sons





Total Length	37.5'
45° Elbow	4'
90° Elbow	15'
Termination	30'
TEL	**86.5'**

Calculate Static Pressure

$$\frac{80\ cfm}{3.14x(4sqin)} = 919.5\ fpm$$

As Designed

$$\frac{Friction\ Loss}{100'} = \frac{2.74\left[\frac{V_{FPM}}{1000}\right]^{1.9}}{[D_{in}]^{1.22}}$$

$$\frac{Friction\ Loss}{100'} = \frac{2.74\left[\frac{919.5_{FPM}}{1000}\right]^{1.9}}{[4_{in}]^{1.22}}$$

$$\frac{Friction\ Loss}{100'} = .43" \qquad \frac{86.5\ TEL}{100'}\text{x. } 43" = .37"$$

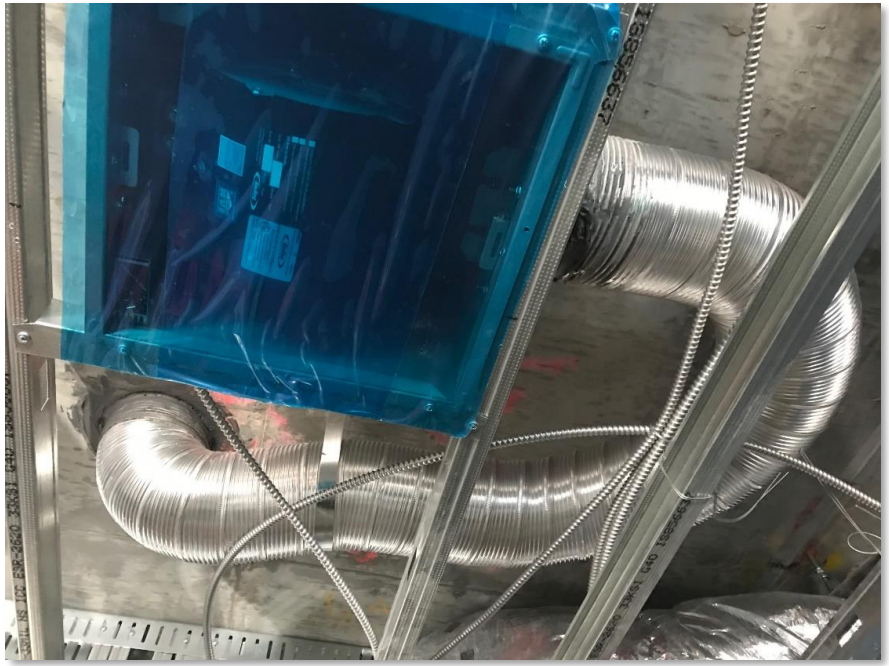
Actual

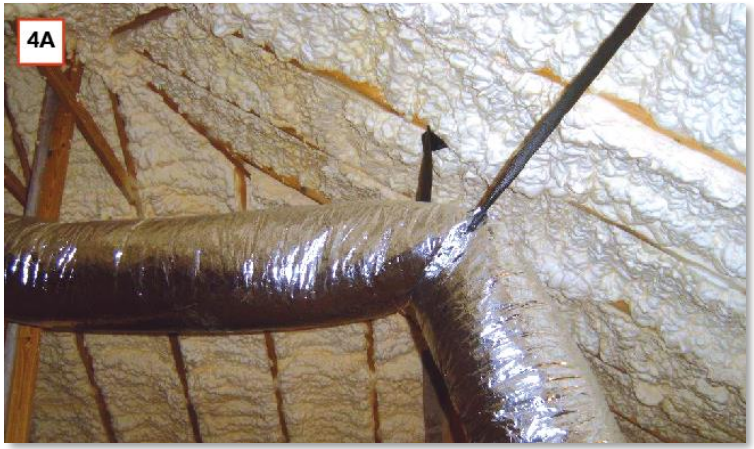
Switching to flex duct adds an additional 37.5’ of effective length

$$\frac{124\ TEL}{100'}\text{x. } 43" = .53"$$

Source: Industrial Ventilation Handbook

Hidden Static Pressure





Requirements and Static Pressure

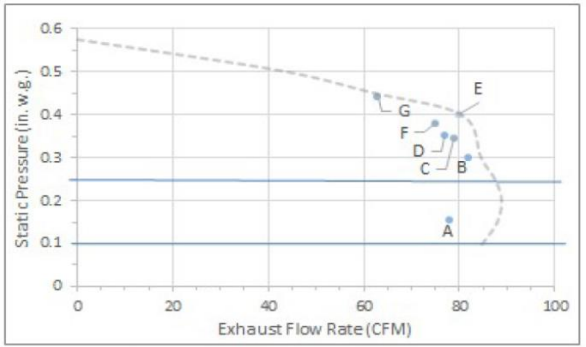
Steven Winter Associates, Inc.
Improving the Built Environment Since 1972

Does Your Exhaust Fan Suck?

Srikanth Puttagunta | Steven Winter Associates, Inc.
February 7, 2018

"It would behoove the residential ventilation industry to move away from the 0.1" w.g. rating and consider the 0.25" w.g. rating as the new minimum performance rating baseline and provide a 0.4" w.g. rating value to better represent common installation scenarios."

0.4" w.g. = real world



Exhaust Fan Curve	Eq. Lgth	Configuration
A - 8' Straight Flex	48' TEL	
B - 20' Straight Flex	60' TEL	
C - 90° Turn, Straight Flex	80' TEL	
D - 180° Turn, Straight Flex	100' TEL	
E - 16' Straight Loose Flex	80' TEL	
F - 90° Turn, Loose Flex	100' TEL	
G - 180° Turn, Loose Flex	120' TEL	

Figure 9. Impact of Duct Configuration on Static Pressure

It would behoove the industry to move away from the 0.1" w.g. rating, consider the 0.25" w.g. rating as the new minimum performance rating baseline, and provide a 0.4" w.g. rating value to better represent common installation scenarios.

Certified and Tested

- Residential grade ventilation products do not offer certified performance at installed static pressures
- Certified performance and thoughtful design are critical to a properly functioning exhaust fan system

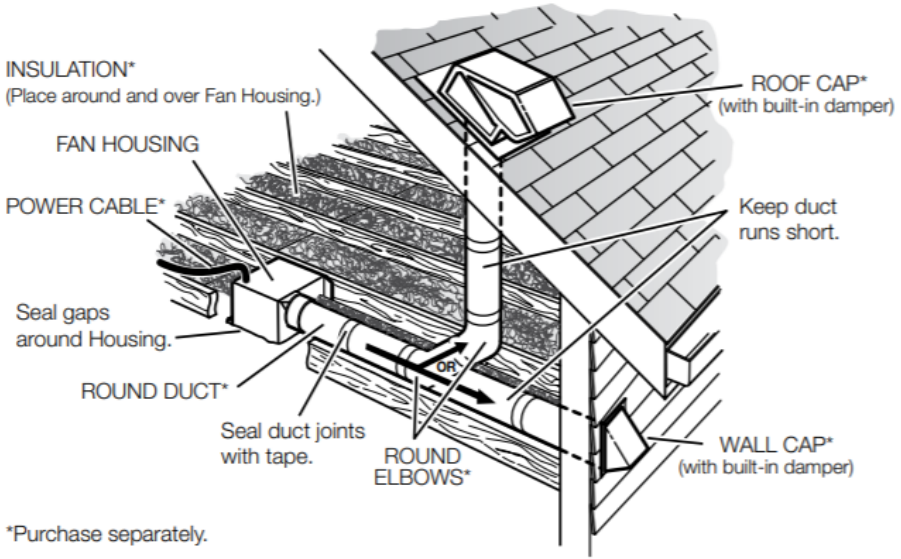
Typical Installation

The ducting from this fan to the outside of the building has a strong effect on the air flow, noise and energy use of the fan. Use the shortest, straightest duct routing possible for best performance, and avoid installing the fan with smaller ducts than recommended. Insulation around the ducts can reduce energy loss and inhibit mold growth. Fans installed with existing ducts may not achieve their rated airflow.

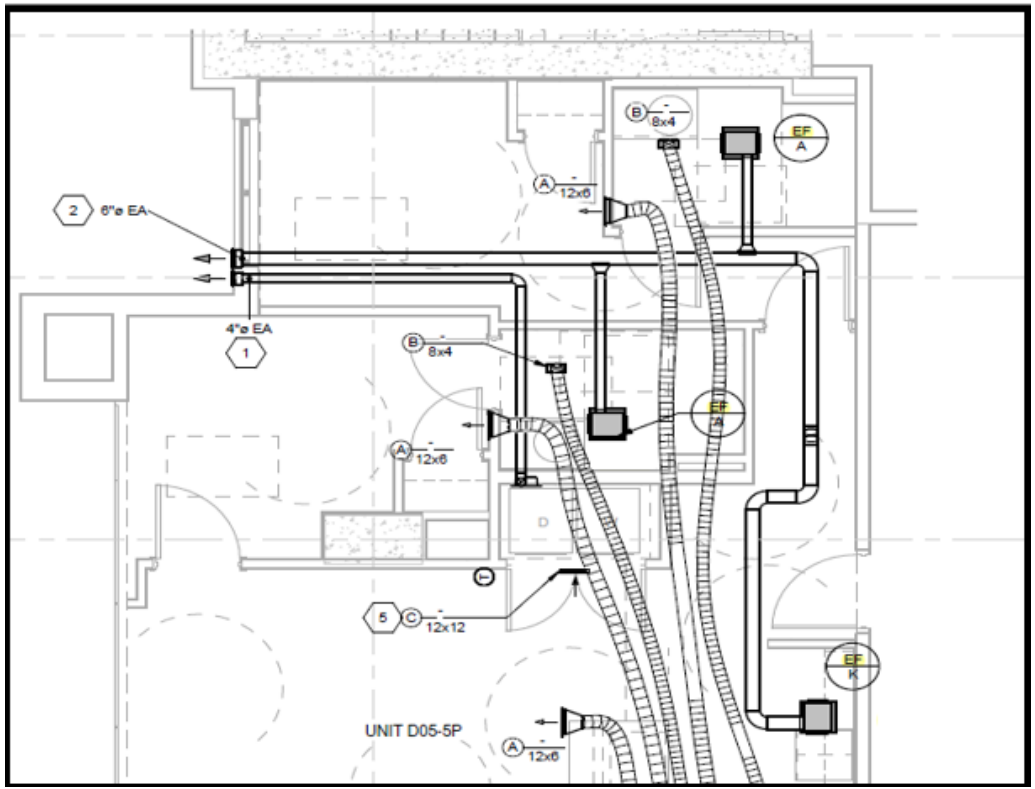
Rigid metal duct is recommended for optimal fan performance.

Ensure duct joints and exterior penetrations are sealed with caulk or other similar material to create an air-tight path and to minimize building heat loss and gain and reduce the potential for condensation.

Place/wrap insulation around duct and/or fan to in order to minimize possible condensation buildup within the duct, as well as minimize building heat loss and gain.



Design Impacts on Performance



Sound Considerations

- Sones are a linear measurement of sound
  - Industry standard for rating bath fans
  - A rating of 2 sones is twice as loud as 1 sone
- One sone is equivalent to the sound of a quiet refrigerator heard from five feet away in an acoustically average room
- Choose a fan that is under 1 Sone when possible
  - Fans are less likely to be used if they are too noisy for the tenants

Bathroom Exhaust Fan Best Practices

- Run fan for at least 20 minutes after shower
- Consider automated ways to run fan
  - Humidity sensor, motion sensor, timer, etc.
- Consider a fan with a sone rating of less than 1
- Evaluate different motor technologies to ensure performance under higher-than-expected static pressure

Motor Technology

- The term “DC motor” doesn’t necessarily mean the fan is high performing
- Understand the differences and what it means for your design

DC motor

High Performance

Key Takeaways

Poor Indoor Air Quality causes adverse health effects

ASHRAE 62.2 is an important standard in managing IAQ

Selecting bath fans at realistic static pressures will ensure proper ventilation

Resources

- **AMCA International**: www.amca.org
- **AMCA Lab Energy Star Certification**: www.amca.org/test
- **ASHRAE Standard 62.2-2019:** https://www.ashrae.org *(Available for purchase)*
- **California Green Building Standards Code:** https://codes.iccsafe.org/content/CAGBSC2016/chapter-4-residential-mandatory-measures

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- Presenters: Michael Ivanovich, AMCA International
  Ryan Colker, International Code Council
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